Radioactive occurrences and uranium production in Arizona

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Final Report

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ABSTRACT

Nine hundred and sixty-five natural radioactive occurrences of uranium, some containing thorium, are known for Arizona. Of these, 328 localities were the source of 18.1 million pounds of U_3O_8 between 1948 and 1970. About 43 million pounds of V_2O_5 were present in the uranium ores. Ninety-nine percent of Arizona's total production is from the Triassic-Jurassic sedimentary rocks of the Colorado Plateau, approximately half of which came from the Salt Wash Member of the Morrison Formation in the Carrizo and Lukachukai Mountains. Historically, only a small amount of uranium has been produced from the Basin and Range Province. However, recent exploration has shown significant uranium potential in late Tertiary sediments in this region.

Arizona's largest single uranium deposit has been at the Monument No. 2 Mine of Apache County. There, about 5.2 million pounds of U_3O_8 and nearly eleven million pounds of V_2O_5 were produced from a single channel deposit in the Shinarump Member of the Triassic Chinle Formation.

Eighteen major groupings of uranium occurrences are recognized in Arizona for the purposes of classifications; eleven on the Colorado Plateau portion of the State, and seven more in the Basin and Range-Transition Zone portion. These are summarized as follows:

Colorado Plateau:

1. Pennsylvanian-Permian Naco and Supai Formations
2. Permian Kaibab Limestone
** 3. Jurassic Morrison Fm., Salt Wash Member
** 4. Triassic Chinle Fm.
5. Triassic Moenkopi Fm., basal portion
* 6. Jurassic Kayenta Fm.
* 7. Jurassic Navajo Ss.
* 8. Cretaceous Toreva Fm., of the Mesaverde Group
9. Cretaceous Dakota Fm.
** 10. Plateau breccia pipes
* 11. Pliocene Hopi Buttes, fine-grained clastics and tuffs

Southern Arizona:

** 12. Precambrian Dripping Spring Quartzite
* 13. Cretaceous sandstone
* 14. Oligocene, Miocene, Pliocene, fine-grained clastics
15. Mid-Tertiary volcanic rocks
* 16. Jurassic-Cretaceous volcanics, southernmost Arizona
** 17. Laramide porphyry copper deposits
* 18. Vein/pegmatite/granite occurrences, usually involving Precambrian crystalline terrain

**past or current major source in Arizona
*past or current minor source in Arizona

APPENDIX A

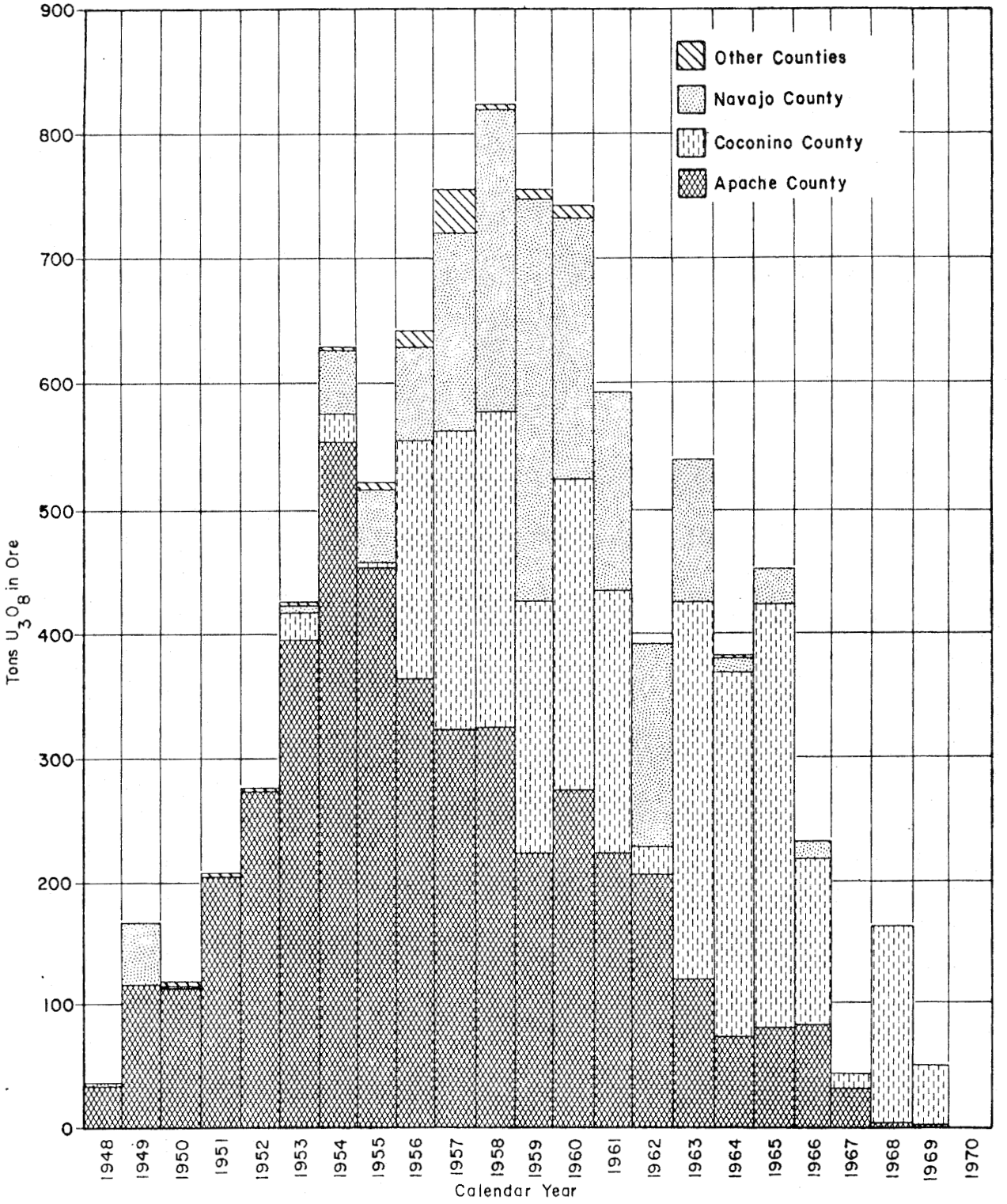
Production Tables and Histograms

ARIZONA URANIUM PRODUCTION, 1948–1970

	Tons of Ore	Pounds of U_3O_8	Average U_3O_8 Grade	Pounds of V_2O_5	Average V_2O_5 Grade	Years of Production
Black Mountain District	16,900	57,600	0.17%	26,000	0.08%	1951–1967
Plateau breccia pipes	511,000	4,374,600	0.43%	—	—	1950–1972
Cameron area[1]	295,100	1,240,000	0.21%	211,900	0.036%	1954–1963 1977–present[2]
Carrizo Mountains	90,300	364,900	0.20%	3,166,200	1.75%	1948–1966
Lukachukai Mountains	724,800	3,483,300	0.24%	14,730,000	1.02%	1950–1968
Monument Valley	1,322,000	8,670,000	0.33%	24,361,400	0.92%	1948–1969
Sierra Ancha District	25,500	115,200	0.23%	—	—	1953–1960 1977–present[3]
Southern Arizona; all sources in Cochise, Graham, Pima, Santa Cruz, Yavapai and Yuma Counties (11 producers)	11,600	36,700	—	10,300	—	1954–1959 1977–present[4]
TOTALS	2,997,200	18,342,300	0.31%	42,505,800	—	

[1] Includes Marble Canyon-Vermillion Cliffs area and one producer in the Kaibab Ls.
[2] One known producer in Holbrook area
[3] Two known producers; one in Pinal Mts., one in Sierra Ancha
[4] One known producer in Rincon Mts. area

Table 2



ARIZONA URANIUM PRODUCTION, 1948-1970

Table 3

TABLE 4
ARIZONA URANIUM PRODUCTION
1948 - 1970

Tons U_3O_8

	Apache	Coconino	Navajo	Gila	Other Counties*
1948	34.33	-	0.55	--	--
1949	116.45	0.08	0.74	--	--
1950	115.43	0.01	0.52	--	1.00 (Mo, Y)
1951	206.15	0.17	0.01	--	0.17 (S)
1952	277.02	0.03	0.12	--	0.65 (Mo, S)
1953	397.11	20.86	3.12	1.80	0.2 (Mo)
1954	552.85	26.05	47.63	3.20	0.3 (Mo)
1955	456.54	3.53	58.27	6.15	0.2 (Ma, Mo, P,S,Y)
1956	367.97	191.00	74.60	12.82	0.4 (C, Mo, P,S,Y)
1957	321.30	240.25	158.77	24.68	9.6 (Ma, P,S,Y)
1958	323.12	255.12	242.20	--	1.95 (C, Y)
1959	223.49	203.11	323.04	0.02	7.60 (C, Y)
1960	271.10	261.30	202.76	7.48	0.0X (C)
1961	224.04	211.46	159.66	--	--
1962	203.77	23.57	163.33	--	--
1963	119.93	307.42	111.64	--	--
1964	71.86	296.02	11.58	--	0.26 (Mo)
1965	82.29	340.37	27.71	--	--
1966	83.30	134.34	14.08	--	--
1967	30.68	12.78	--	--	--
1968	1.95	160.58	--	--	--
1969	0.24	49.51	--	--	--
1970	--	--	--	--	--

* C - Cochise, G - Gila, Ma - Maricopa, Mo - Mohave, P - Pima, S - Santa Cruz, Y - Yavapai
Small "no pay" shipments from Graham and Yuma counties not included.

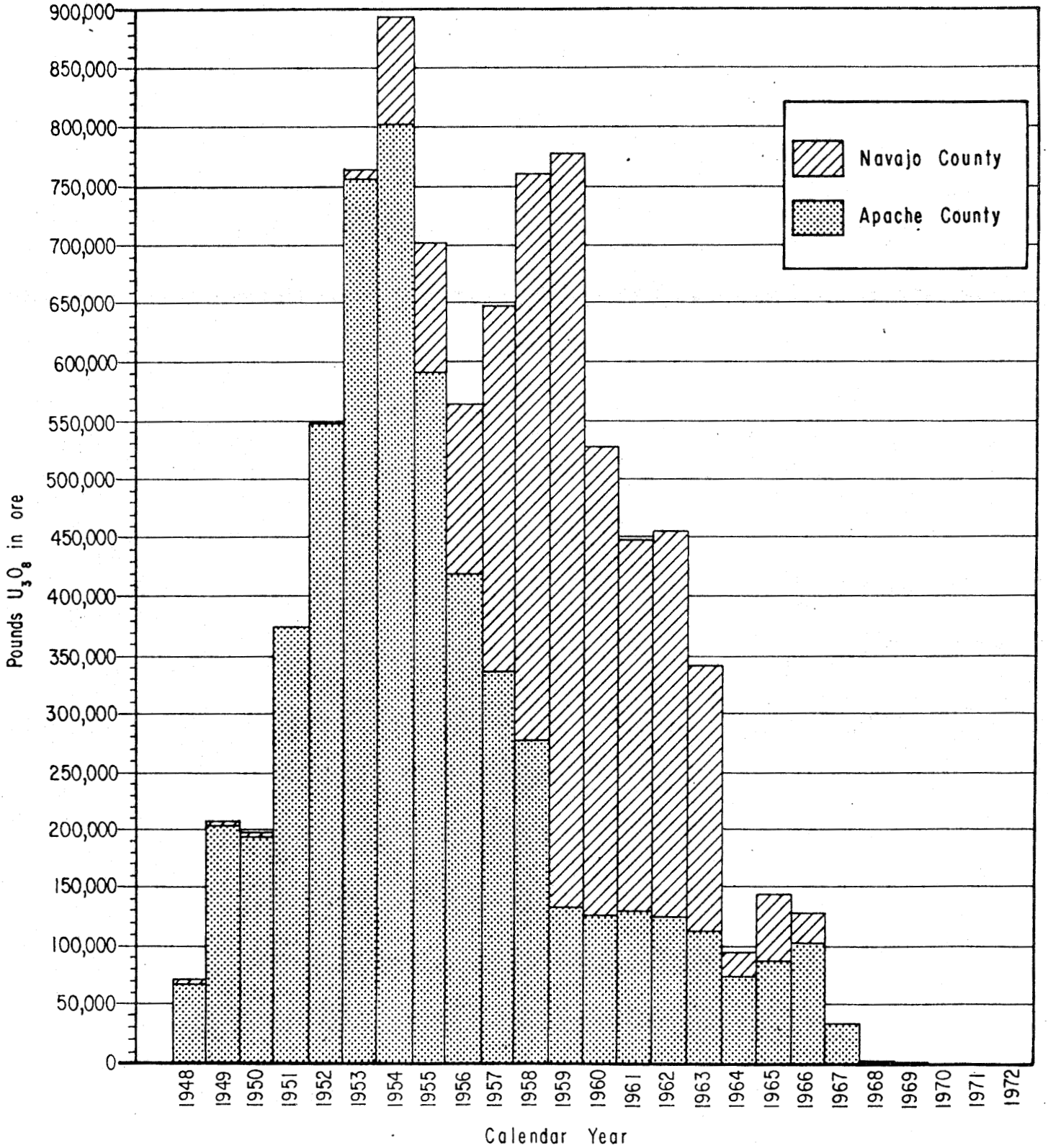
Compiled by Elizabeth A. Learned, February, 1980
U.S. Department of Energy
Grand Junction Office

TABLE 5 Summary Information of Number of Occurrences, Number of Producers, and Uranium-Vanadium Production Listed by County.

County	Total Number of Occurrences and Mines	Total Number of Producers *	Total Pounds of U_3O_8 *	Associated Pounds of V_2O_5 **
Apache	201	147	9,522,637	40,688,132
Cochise	32	2	220	93
Coconino	163	105	5,638,208	211,893
Gila	153	18	122,213	6,493
Graham	27	1	30	11
Greenlee	1	0	0	0
Maricopa	33	3	162	6
Mohave	87	8	15,204	12,091
Navajo	82	34	2,764,080	2,074,161
Pima	46	4	239	49
Pinal	23	0	0	0
Santa Cruz	26	3	2,964	2
Yavapai	55	2	33,253	10,112
Yuma	36	1	3	0
TOTAL	965	328	18,099,213	43,003,043

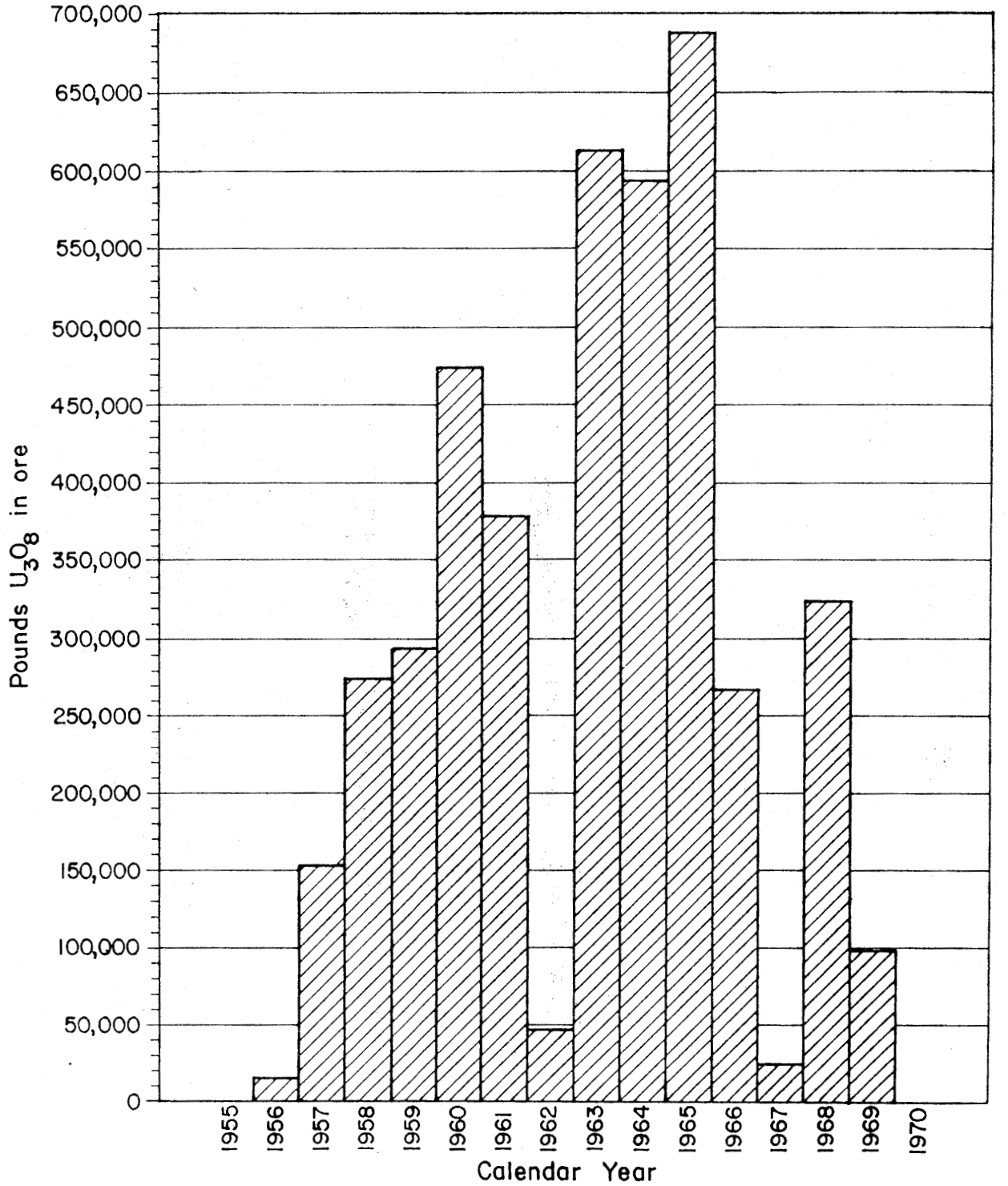
Arizona Total
(to January 1, 1970)

* Includes small amounts of no-pay (low grade) ores from certin localities.
** Only Apache County is probably complete. Not all Cameron, Anderson Mine, etc., ores were assayed for V_2O_5



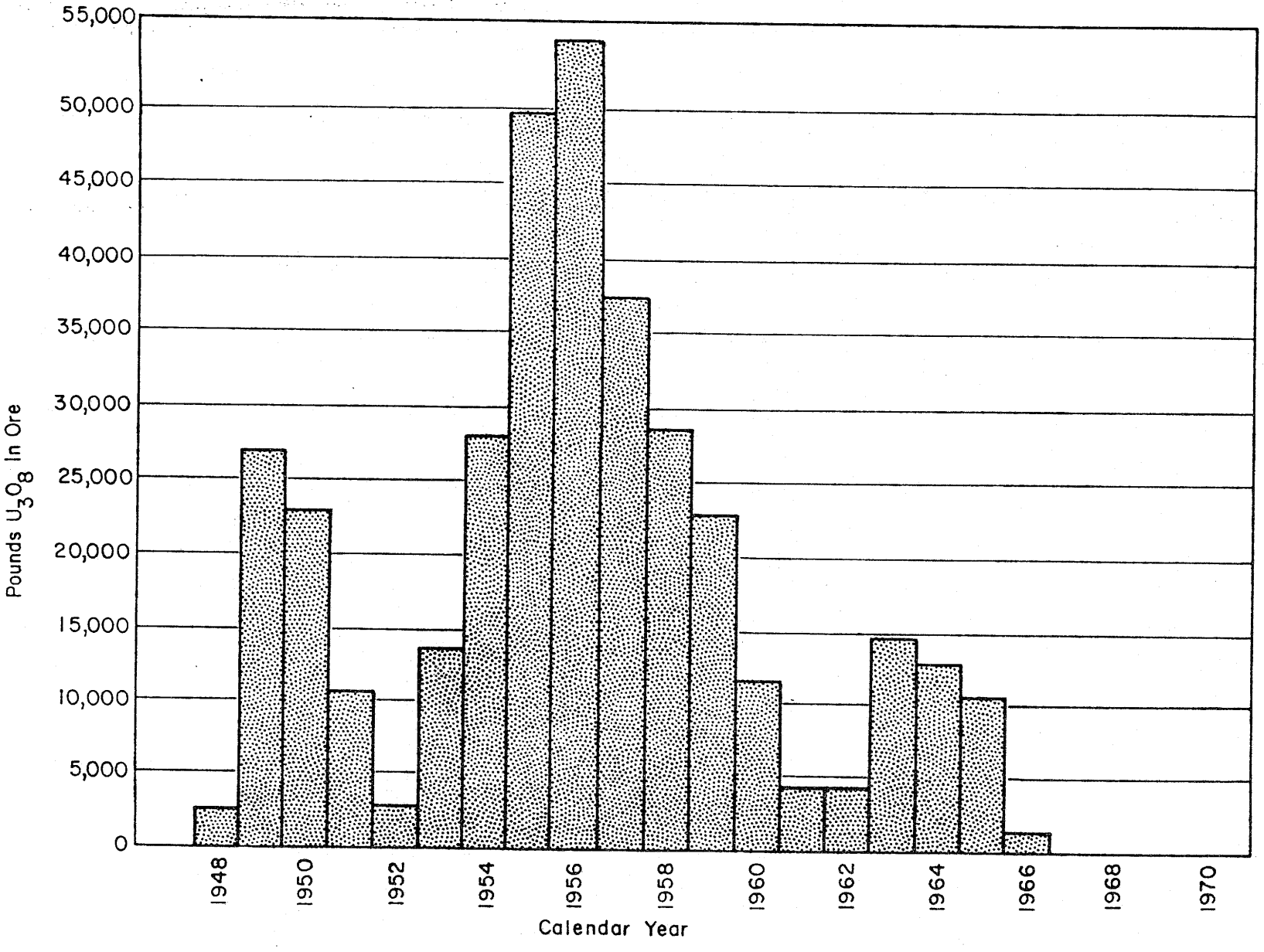
Uranium production Monument Valley, Apache and Navajo Counties, Arizona.

Table 6



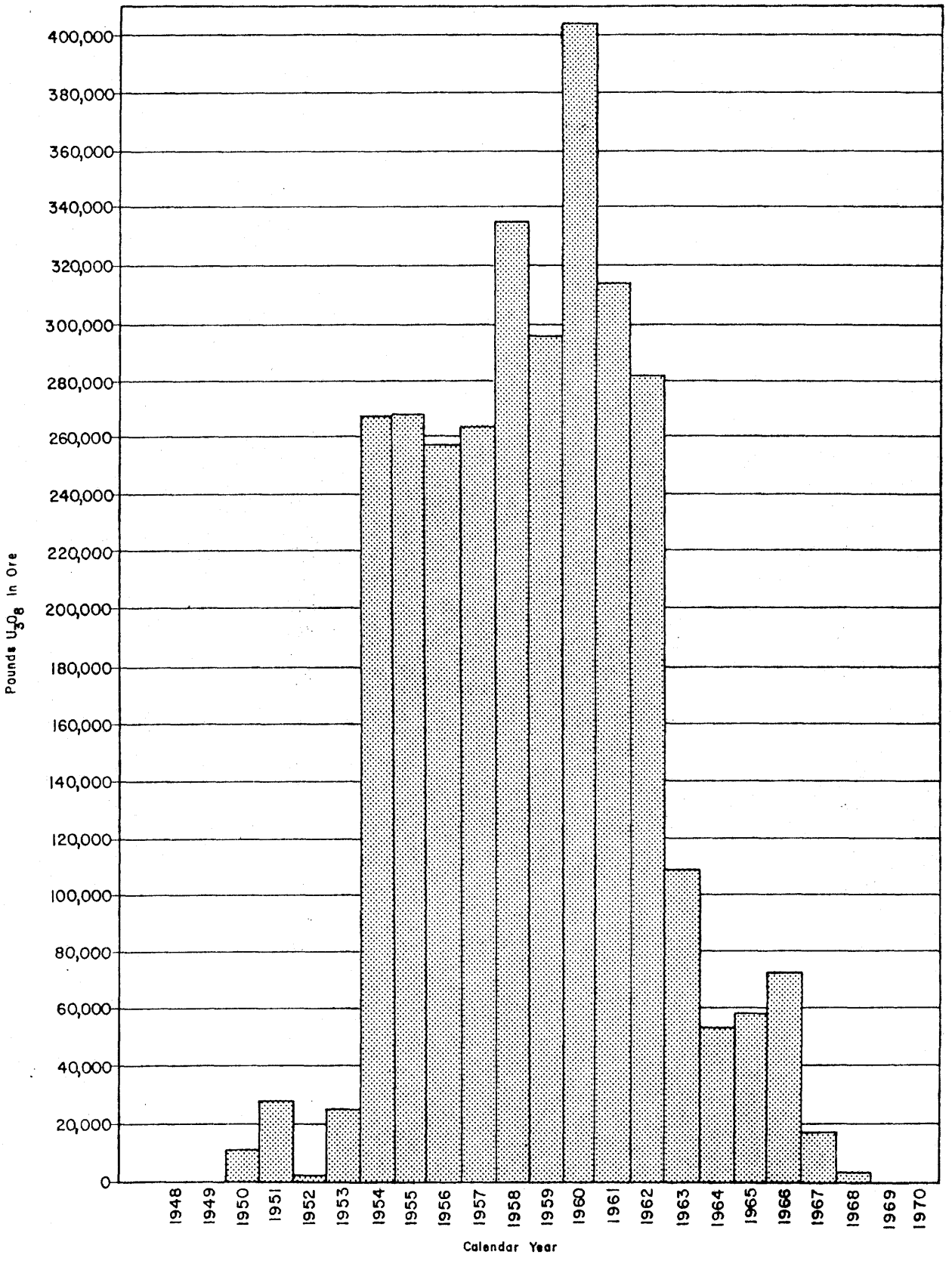
Uranium Production Orphan Lode Mine, Coconino County, Arizona

Table 7



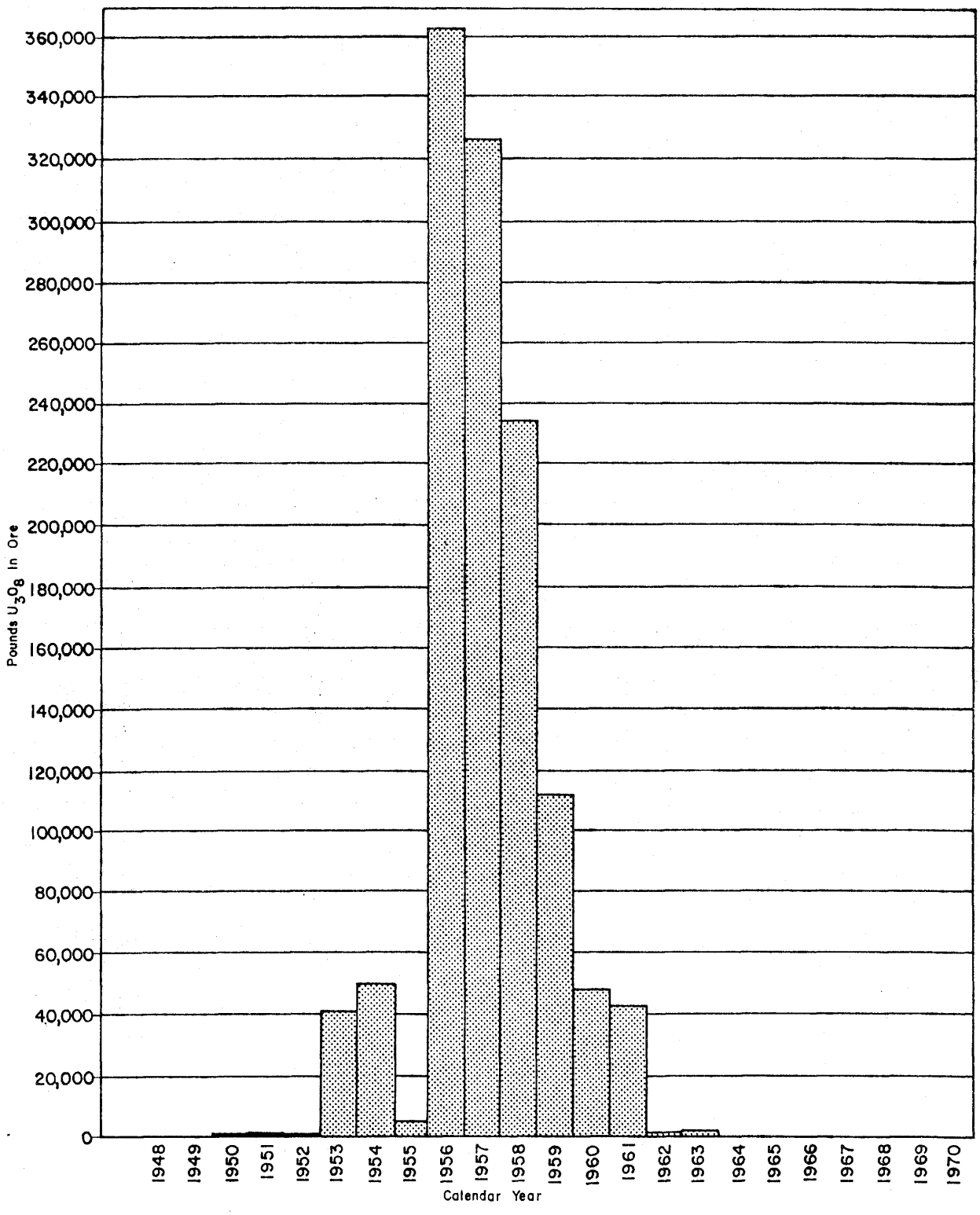
Uranium production Carrizo Mountains, Apache County, Arizona.

Table 8



Uranium production Lukachukai Mountains, Apache County, Arizona.

Table 9



Uranium production Cameron area, Coconino County, Arizona.

Table 10

ARIZONA URANIUM EXPLORATION TRENDS

Year	Year End Acres Held for Exploration and Development x 1,000	Surface Drilling	
		Number of Holes	Footage
1980*	---	601	260,508
1979	1,662	663	378,380
1978	1,282	1,372	688,291
1977	1,212	1,035	500,382
1976	1,021	1,465	544,740
1975	942	1,165	176,162
1974	819	127	52,013
1973	754	50	8,750
1972	486	37	6,000
1971	231	24	2,200
1970	221	14	3,510
1969	272	415	43,203
1968	---	881	114,705
1967	---	331	69,495
1966	---	24	5,330
1965	2	73	9,508
1964	---	102	16,913

*Statewide total of 23 drilling projects, with 5 projects in each of Gila, Mohave, and Yavapai counties, the remaining projects in Cochise, Coconino, and Navajo counties. One project in undisclosed county..

Compiled from DOE statistics by W. Chenoweth

Table II

APPENDIX B
SYNOPSIS OF HISTORY AND MINING DEVELOPMENT

Arizona Early History and AEC Involvement

1. In 1900, first recorded efforts in Colorado to extract uranium and vanadium from carnotite ores by Cashin Copper Company. Early success made the French owners form the American Rare Metals Mining and Manufacturing Company, which, in 1901, built the first mill for uranium-vanadium extraction from Colorado Plateau ores located at Stevens Camp, Summit Creek, Slick Rock mining district. Use of vanadium in hard steel alloys was becoming important, and its use in WWI war effort spurred the industry on.

2. During 1900-124 a booming industry in Colorado extracted radium from carnotite and pitchblende ores for medical use, based on pioneering work of the Curies in Paris. Between 1913 and 1919 about 39 grams of radium, valued at between 60,000 and 100,000 dollars per gram, were produced from Colorado Plateau ores. Best ores went to the Coke Ovens mill at the head of Paradox Valley, owned by Standard Chemical Company of Pittsburgh, Pennsylvania. This mill operated between 1910 and 1924. This industry sparked early exploration interest in NE Arizona. America's radium extraction industry died in 1924 upon discovery of rich Belgian Congo pitchblende ores. See Carrizo Mountains, note 2.

3. Organization in 1919 of Vanadium Corporation of America, which succeeded General Vanadium Company. They took over roscoelite properties in Placerville district, owned by Primos Chemical Company. VCA became important in the vanadium industry which was rapidly growing.

4. Earliest reports on uranium occurrences in Arizona are by Gregory (1917) and Butler and Allen (1921) for Monument Valley, and by Butler and Allen (1921) for the Tombstone area and the Santa Rita Mountains. An unpublished report by Staver (1921) discussed vanadium-uranium ores in the Salt Wash sediments of the eastern Carrizo Mountains of Arizona and New Mexico. F. L. Hess discussed Carrizo Mountains vanadium occurrences in 1933 AIME Lindgren volume.

5. Early mining for vanadium during 1942-1944 in Monument Valley and Carrizo Mountains by VCA, spurred by promotional activity in the federal government's Metal Reserves Company regarding vanadium procurement.

6. AEC (Atomic Energy Commission) was created in 1947. That year, first contracts signed with VCA for mining. Begin mining for uranium in Monument Valley and Carrizo Mountains in 1948.

7. In 1948-1949 AEC announced ore-buying schedules and other incentives which stimulated prospecting interest throughout the States (Circulars 1-5). These circulars announced, among other things, prices paid for certain types of high-grade ores and carnotite-roscoelite ores, and bonus payments for ores assaying better than certain cut-off grades, for ores purchased before March 31, 1962.

8. To encourage development of new domestic uranium supplies, AEC announced Circular 6, issued effective March 1, 1951. Circular 6 offered a bonus payment on the first 10,000 lbs of U_3O_8 supplied by any property or mine in addition to the Circular 1-5 price schedules, for those mines which had not produced any uranium prior to that time. For ores that continually maintained more than 0.20% U_3O_8, an operation could receive up to $35,000 in Circular 6 bonus payments. The original Circular 6 program ran until March 31, 1960.

9. Nationwide, the search for uranium proved so successful that in 1961 the AEC announced that purchases of uranium ore after April 1, 1962, would be limited to annual quotas allocated to individual properties. Also from that date until the end of 1966, instead of buying ore at the graduated prices previously in effect, the Commission would pay $8.00 per pound for U_3O_8 in concentrates produced mostly from reserves discovered before November 24, 1958. As a result of this change, the production of uranium in the United States declined in 1961 for the first time since 1948. In 1962, the AEC proposed to continue the purchase of uranium until 1971 from those suppliers who would agree to defer delivery of a part of their pre-1966 quotas until 1967 and 1968, with the price paid in 1969 and 1970 not to exceed $6.70 per pound of U_3O_8. This was the so-called "stretch-out" program. Since January 1, 1971, when the AEC ceased its procurement program, the only market for uranium has been the nuclear electrical power industry.

10. The Tuba City mill did not "stretch-out," and their contract with AEC expired December 31, 1966.

11. Other mills receiving Arizona production which didn't "stretch-out" were the Climax Uranium Corporation mill at Grand Junction and the Cotter Corporation mill at Canon City, Colorado. The Atlas Minerals mill at Mexican Hat closed in 1965, but their contracts were consolidated with the Moab mill contract, which "stretched-out".

12. AEC buying station and mill at Monticello, Utah, closed December 31, 1959. VCA mill at Shiprock closed 1968 due to lack of ore. Rare Metals mill at Tuba City closed September, 1966, due to closing of Orphan Lode in August, 1966.

References

O'Rear (1966)
Bruyn, K. (1955) "Uranium Country" U. of Colorado Press, 165 p.

Carrizo Mountains

1. Uranium-bearing outcrops discovered in 1918 by John Wade of Farmington, New Mexico, who operated the Sweetwater Trading Post. He and local Navajos located numerous ore-bearing outcrops in eastern Carrizos, with best ones near MP-16.

2. Wade, operating as the Carriso Uranium Company, acquired 41 claims around MP-16 in 1920, and hired Navajos to mine high-grade ore for radium content (probably in part at Syracuse (RF&R) Mine). Thirty-seven gunny sacks were shipped to Beclabito T. P. in 1921 (?) and eventually to Colorado where several companies were buying radium ores. A probable buying point was Standard Chemical Company's Coke Ovens station near Naturita. The market for vanadium that Wade was anticipating never materialized and operations ceased. Area remained inactive until the 1940's.

3. In late 1941, VCA (Vanadium Corporation of America) entered into a lease arrangement with the Navajo Tribe for the 17 plots in the Western Carrizos which they mined during 1942-44 ("West Reservation Lease"). VCA ore was trucked to Monticello. In July 1942 they leased 12 plots in the Eastern Carrizos of Arizona and New Mexico ("East Reservation Lease").

4. In 1942 the federal government formed the Metal Reserves Company to expedite domestic vanadium production for the war effort. This program stimulated interest in the Carrizos and elsewhere. Mills were constructed at Monticello, Utah, and Durango, Colorado, and operated by VCA and USV, respectively.

5. Early in 1942, Curran Brothers and Wade (CB&W) of Farmington, New Mexico, obtained a prospecting lease from the U.S. Indian Service, Navajo agency and selected two plots, Syracuse and Valley View, for mining. Several Curran brothers had previous experience in Utah-Colorado prospecting for uranium.

6. During 1942-1944, Wade, Curran and Company developed the Martin, Saytah, Saytah Canyon, Main Claim, Eurida, and Syracuse (RF&R) Mines. Ore mined by Wade, Curran and Company was shipped by truck and rail to Metal Reserve's mill at Durango. VCA shipped ore from west reservation plots 1 and 6-13 during 1943-44 to its mill at Monticello, Utah.

7. Total 1942-44 production from the Carrizos (Martin, North Martin, Saytah, Main Claim (MC), Saytah Canyon, Eurida and Rattlesnake Mines plus mines near milepost 16 along Arizona-New Mexico border) total 8,400 tons @ 2.18% V_2O_5 and about 0.17% U_3O_8 . Much of the uranium left behind in the mill tailings at Durango, Colorado and Monticello, Utah, were reprocessed at Durango for uranium in the late forties as part of the Manhattan Project. The Metal Reserve's program terminated March, 1944, resulting in shutting down of Carrizo vanadium mines.

8. Union Mines Development Corporation (UMDC) was organized in 1943 by the Army Corps of Engineers under the Manhattan Project to evaluate uranium resources of the Salt Wash Member of the Morrison Formation (and the Entrada Formation in Colorado) on the Colorado Plateau. UMDC's chief field geologist, based at their Grand Junction field office, was Benjamin N. Webber. Party chiefs in Arizona included John Harshbarger (for Eurida and Segi Ho Cho areas) and A. H. Coleman (for east Carrizo area). Elements of UMDC involvement and works are found in RMO-444 by E. H. Eakland, Jr. (1st Eurida Party chief), and RMO-437 (final report of UMDC), and RMO-1000 (summary of Colorado Plateau work). UMDC was active through 1946. UMDC geologists recommended the acquisition of 960 acres in the western and

Carrizo Mountains (continued)

northwest Carrizos by federal government leases that they thought had the best uranium potential. Although UMDC knew about Monument Valley occurrences, they did no work in that region.

9. In 1947 the AEC was created and began a procurement program on the Colorado Plateau. First procurement contracts with VCA signed May 1947.

10. Mining for uranium for the AEC was resumed by VCA in late 1948. Ore was hauled first to Naturita, Colorado, and later to Durango, Colorado. Early independent miners shipped ore to Durango.

11. In February, 1949, a contract between AEC and VCA allowing purchases of concentrates from VCA's Durango mill increased VCA Carrizo production.

12. In January, 1952, AEC opened a buying station at Shiprock, New Mexico, further boosting production from Carrizos.

13. New AEC and company drilling started in 1953, resulting in renewed mining along Saytah Wash and Cove Mesa. Most productive years were 1955-1959 for the Carrizos. Late 1954, Kerr-McGee Shiprock mill opened, which received ore from independent mines. AEC Shiprock buying station closed.

14. 1963-1966 production came from Kerr McGee's Block K Mine (discovered by a single AEC drill hole), Cove Mesa plot 7, Cato Sells' Cove Mesa Mines, VCA's Plot 6 and adjacent Hoskie Henry properties.

15. Last shipments made in 1966 as known ore bodies were depleted.

16. Total Carrizo Mountains production, including New Mexico's majority of eastern Carrizo area, is 119,558 tons containing 524,827 lbs U_3O_8 and 4,650,980 lbs of V_2O_5. Arizona's portion of this is 90,300 tons containing 364,900 lbs $U_3O_8$and 3,166,200 lbs V_2O_5.

Lukachukai Mountains

1. Only the northwest tip of the mountains were examined in 1943-1946 by UMDC (Union Mines Development Corporation) personnel. Due to lack of occurrences on Mexican Cry Mesa, and the false belief that the pre-Chuska unconformity cut out all Salt Wash outcrops to the southeast, the UMDC declared the Lukachukais to be an unpromising area for further searching. (UMDC had been organized for under the directorship of the Army Corps of Engineers, and given the task of accessing the nation's uranium potential).

2. Dan Hayes, raised near Hite, Utah, prospected for copper near his home on claims originally worked by his father. In 1948 he sold the claims, located in eastern Utah's White Canyon area, to Cooper-Bronson Mining Company which developed them into the rich Happy Jack Mine, a copper-uranium association in Moenkopi Formation. Hayes also held valuable claims in Lisbon Valley next to the fabulous find in 1952 by Charlie Steen of his Mi Vida Mine.

Lukachukai Mountains (continued)

3. Dan Phillips, Koley Black (local Navajos) and Dan Hayes prospected in 1949 in the Lukachukais south of Cove School and staked claims which bore the names of the two Navajos. Willie Cisco, another Navajo prospector, showed ore samples from the southside Lukachukai mesas to geologists of the Walter Duncan Mining Company of Cortez, Colorado. F. A. Sitton of Dove Creek, Colorado, followed advice of Hayes, and negotiated with the B.I.A. and Navajo Tribe to obtain first Lukachukai mining permits. He organized F. A. Sitton, Inc. and built first roads up Mesa I in 1950 and initiated shipments of ore out of Lukachukais in that year. He shipped from Mesas I, II and IV.
4. Climax Uranium Company began prospecting about this same time and acquired mining permits on Mesa IV½ from Frank Nacheenbetah in 1950.
5. In August, 1951 the Navajo Uranium Company of Cortez, Colorado, (under R. O. Dulaney, Jr., Edward Key, Jr., and "Buffalo" Kennedy) acquired Sitton's interest and continued mining on Mesa II, etc.
6. AEC began drill projects in 1950 and built more access roads. By spring 1951, drill programs were in progress on Mesas I, II, III and IV. AEC drill programs ran until August, 1955.
7. Transfer of Navajo Uranium Company's interests to Kerr-McGee Oil Industries, Inc., approved by the B.I.A. January 26, 1953 (transfer of operations underway in fall, 1952). Kerr-McGee was the first major oil company to engage in full-scale uranium exploration. Kennedy was retained as manager of Kerr-McGee's Navajo Uranium Exploration Division.
8. AEC buying station opened in Shiprock, New Mexico in January 1952. Kerr-McGee built a mill there which began operating in October, 1954.
9. VCA acquired Kerr-McGee's Shiprock mill and Lukachukai leases in March, 1963 with B.I.A. approval on July 29, 1963. The mill finally closed in 1968 due to lack of ore.
10. Climax Uranium Corporation properties (Frank #1, Frank Jr.) shipped their ore to the Climax mill at Grand Junction, Colorado. Since Climax didn't participate in the AEC's stretch-out program (see note later), their production in 1966-67 went for non-AEC sales to electric utility companies.
11. Final shipments from the Lukachukais in May, 1968.
12. Foote Minerals of Naturita, Colorado, purchased VCA interests around 1970.

References

Chenoweth and Malan (1973)
Dare (1961),(USBM IC-8011)
Chenoweth (pers.comm.,1981)

Monument Valley

1. Carnotite noted by Gregory in 1917 (USGS Prof. Paper 93).
2. VCA leased ore-bearing outcrops in August, 1942 (properties became Monument #'s 1 and 2).
3. 1942-44 vanadium ores were shipped to Monticello, Utah (a few thousand tons came from Monument 1 - no Monument 2 production during 1942-44 can be confirmed).
4. Mining resumed at Monument 1 and 2 in 1948 by VCA under AEC program. Ore shipped to VCA mill at Naturita, Colorado, later Durango.
5. Early non-VCA ore shipped to AEC mill at Monticello (1948 - early 1950's).
6. Drilling in 1955-56 located large deposits in the Ojetah syncline (Moonlight, Starlight, etc.).
7. From 1955-1968, VCA operated a concentrator plant located one mile east of Monument 2 Mine, built because of high transportation costs of low-grade ores to their Durango or Shiprock mills. From summer 1955 to July 1964 a mechanical separator concentrated high grade slimes from low grade sand residues. From 1964 to 1968 a heap leach facility produced yellowcake from low grade new ore and sand residue. Monument 2 ores were further processed at VCA facilities at Naturita in 1948-1958, Durango in 1949-1963, and Shiprock in 1963-1968.
8. During 1957-1963, a mill at Mexican Hat, Utah was operated by TZ minerals (Texas-Zinc) for Texaco and New Jersey Zinc, and by Atlas Minerals in 1963-65. This mill recovered copper from Monument Valley ores. Nearly all of the Monument Valley VCA ores were processed here. Some small operators, distrustful of TZ, shipped their ores to Tuba City, Arizona.
9. Last Monument Valley ore was from Monument #2 in 1969, just after the VCA mill at Shiprock closed. This shipment went to Atlas Minerals Moab mill.

References

Chenoweth and Malan (1973)
Ford, Bacon, Davis (1977, p.2-2)

Cameron Area

1. Hosteen Nez, an independent Navajo prospector, found uranium ore in the Kayenta Formation east of Cameron in 1950 and had Mr. L. Hubbell, the trader at Winslow, confirm the identification with AEC personnel. Early shipments were made to Durango for low lime ore, and to Monticello for high lime ore.

Cameron Area (continued)

2. AEC-BIA negotiations in 1949-50 at Window Rock allowed for the hiring of local Navajo uranium prospectors by Walker-Lybarger Construction Company (AEC prime contractor). Charlie Huskon, a Cameron resident, became such a prospector and located a number of Chinle Formation occurrences in 1951. Mining permits given to him by the Navajo Tribe were used for mining the Huskon orebodies by the Arrowhead Mining Company of Grand Junction, Colorado. The Navajo prospector program was more successful at Cameron than at any other region on the Reservation.

3. Early shipments of ore went to Monticello, Utah.

4. Arrowhead Uranium Company began shipments in 1953 to Bluewater, New Mexico from Huskon 1-8, 10.

5. Production down in 1955, waiting for local market for the ore.

6. AEC opened buying station on January 12, 1956 at Tuba City. Rare Metals Corporation of America bought out Arrowhead interests (including most of the Charles Huskon properties) in February, 1955 and opened their mill at Tuba City in July, 1956. First concentrate purchased by AEC from the mill July, 1956.

7. a. The Tuba City mill was constructed to receive Cameron area ores. Its lifetime was extended as a result of agreements to process Orphan Lode ores. In early operations, about 300 tons of ore per day were processed using an acid leach, sand-slime separation and resin-in-pulp ion exchange process. High lime ores from the Orphan required the installation of a carbonate leach circuit which was operational during 1963-1965.

   b. During its lifetime, the mill received additional ores from the following areas: Independent Monument Valley producers on Mitchell Mesa and Hoskinnini Mesa, most Black Mountain ores, the last ores from the Anderson Mine and the Sierra Anchas, the Star Claims of Cochise County, and the sole shipment from the Morale Claim of the Hopi Buttes.

   c. Robert S. Shriver, operator of the Rebel Mine, Deer Flats area of White Canyon, Utah, shipped to Tuba City for six months or so. These may represent the only ores processed here which originated from outside Arizona. He also operated the Mitchell Mesa property of Navajo County, where he suffered fatal injuries while hauling ore alone at the mine in 1962.

   d. When the AEC closed the Cutter (Globe) buying station in June, 1957, stockpiles of ores from the Anderson Mine were bought by the Kerr-McGee mill at Grants, while stockpiles of Dripping Spring (Sierra Ancha) ores and miscellaneous ores were bought by Rare Metals' Tuba City mill.

   e. Mill ownership merged into El Paso Natural Gas Company in July, 1962.

Cameron Area (continued)

7. f. With the alkaline leach circuit starting in April, 1963, due to high-lime ore from the Orphan Lode, the plant treated 200 tons per day until it closed in September, 1966.

   g. During its lifetime, the Tuba City mill processed 800,000 tons of ore with average grade of 0.33% U_3O_8 and produced 2,348 tons of U_3O_8 in concentrate form.

8. Peak production in 1956 from Cameron area mines.

9. Most significant Cameron area mines were Jack Daniels (39,800 tons during 1956-1963); Charles Huskon #4 - Paul Huskie #3 (37,800 tons during 1953-1960); Charles Huskon #3 (27,300 tons during 1953-1961); Charles Huskon #1 (23,100 tons during 1951-1961); and Ramco #20 (22,600 tons during 1956-1960). Rare Metals' Ramco pits collectively produced about 47,600 tons of ore between 1956 and 1960. Rare Metals also acquired Charles Huskon Mines #1, 3, 5-8, 10-12, 14, 17 and 26 from Arrowhead in 1955. Charles Huskon Mines #4, 9, 18, 19 and 20 were operated by UTCO Uranium Corporation during 1956-1959.

10. Late production (1961-63) is recorded from Charles Huskon #1, 3, 6, 10, 11, 12 and 17; Evans Huskon #2; Jack Daniels; Julius Chee #3; Yazzie #2, 101 and 312; and Section 9.

11. Cameron discoveries in the early 1950's led to considerable prospecting around the Black Mesa basin, but no similar deposits were found outside of some already known ones around Holbrook.

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Orphan Lode

1. Original Orphan Lode claim staked by Daniel L. Hogan and Henry Ward in 1893.

2. Continued copper prospecting through early 1920's. Hogan patented the claim in 1906, three years before the establishment of Grand Canyon National Park. Patent papers signed by President Theodore Roosevelt. Hogan had been one of Roosevelt's "Rough Riders" in Cuba.

3. Claim sold to Madeline Jacobs in August, 1946.

Orphan Lode (continued)

4. Radioactivity in ore samples from old workings noted by Harry Granger, USGS, in 1951. (Tested samples were in a garage in Prescott).
5. Golden Crown Mining Company acquired mineral rights in 1953. Five short jack hammer holes drilled in old Hogan adit in 1955-56.
6. Based on drilling results an early tramway was constructed in March, 1956, but proved ineffective. A second tramway was built in May, 1956.
7. First ore shipped April, 1956. Early production was about 1,000 tons per month @ 1.0% U_3O_8.
8. Drilling in 1958-59 located "B" ore zone and the annular ring ore zone.
9. A 1,600 ft shaft and 1,400 ft cross cut to the 400 ft mine level were completed in 1959. In August, 1959 initial ore removal through the shaft. Production increased to 7,000 tons per month at a lower grade of 0.40 - 0.45% U_3O_8.
10. Ore bin on headframe collapsed into shaft in December, 1961; mine shut down and Tuba City mill closed.
11. Bill to mine in Park Service land outside (north) of claim passed U.S. Congress May, 1962, in exchange for NPS ownership of the claim 25 years hence, in 1987. Tuba City mill converted to alkaline leach circuit in 1962 to handle high-lime Orphan ores, and began renewed activity in March, 1963.
12. Mining resumed at Orphan in November, 1962.
13. Tuba City mill (Rare Metals Corporation of America) contract with AEC expired at end of 1966. This plus financial troubles of Western Equities (owners since 1961) caused mine to close in August, 1966. The troubles included FTC suspension of Western Equities stock on the Exchange due to "stock manuvering" by Westex personnel.
14. Cotter Corporation of Canon City, Colorado acquired Orphan from bankruptcy court in 1967. Mine opened and shipments began to the company mill via railroad in 1967. Cotter's AEC contract had expired so they made sales to electric utilities.
15. Due to high costs, etc., Orphan closed in April, 1969.

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Other Parts of Colorado Plateau

1. Intensive prospecting throughout the Colorado Plateau located most surface occurrences by the early 1950's.
2. Uranium was discovered in the old copper mine in Hack Canyon. Initial shipments made in 1950 to AEC buying station at Marysvale, Utah.
3. Uraniferous petrified wood located in Marble Canyon area. Shipments in 1949-50 made to AEC buying station in Monticello, Utah.
4. Salt Wash deposits near Rough Rock (Black Mesa area) shipped by Tom Klee and Tom Wilson to Monticello, Utah and Durango, Colorado in 1951 and 1953.
5. USGS located several uraniferous diatremes in the Hopi Buttes in 1952. Production from Morale claim began in 1954.
6. Ruth and other deposits near Holbrook made initial shipments to Bluewater, New Mexico in 1953.
7. Toreva deposits near Tah Chee School (Black Mountain area) shown to AEC geologists in 1954. Production from the area sent to Bluewater, New Mexico starting that year.

Basin and Range Country

1. USGS reported pitchblende at the Happy Jack Mine, Wrightstown district, Santa Cruz County in 1917 (USGS Bulletin 624 by Schrader).
2. Carnotite reported near Tombstone by Butler and Allen (1921).
3. The AEC procurement program, started in 1947, initiated a massive prospecting effort throughout the Basin and Range country. By the early 1950's most of the surface occurrences had been located. Prospecting was initially confined to the ranges, with very little effort in the basin fill.
4. Early producers were:

   Hillside Mine, Yavapai County (1950),
   White Oak Mine, Santa Cruz County (1951-52) and
   Red Bluff Mine, Gila County (located 1950, produced in 1953)

   All ore was shipped to AEC buying station at Monticello, Utah where there were no restrictions on the type of ore accepted.
5. Development was hindered by lack of market (local buying station) although the AEC paid six cents per ton mile for the first 100 miles of shipping distance, to encourage mining as announced in Circular 5.

Basin and Range Country (continued)

6. Due to intense activity in the Sierra Ancha the AEC established an ore buying station at the Cutter siding just east of Globe, which opened July 5, 1955. Ores were received here from southern Arizona, southern New Mexico, and southern California. The buying station closed because of lack of ore on June 30, 1957.

7. After closure of the Cutter buying station, Sierra Ancha and Anderson Mine ores were shipped to the AEC buying station at Grants, New Mexico.

8. The Anderson Mine of Yavapai County shipped to:

   AEC Cutter during 1955-57,
   AEC Grants during 1957,
   and Rare Metals Mill at Tuba City in 1958-59.

   The Anderson Mine ore at Cutter was later purchased from AEC by Kerr-McGee at Grants; the other Cutter ores were purchased by Rare Metals' Tuba City mill.

9. Some of the last production under the AEC buying program in the Basin and Range Country came from the Hope and Little Joe Mines (Gila County) and the Star claims (Cochise County). This ore was shipped to Tuba City.

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G

GJBX recent reports for Arizona
(1) NURE Aerial Gamma-Ray and Magetic Reconnaissance Survey

Flagstaff	GJBX-157 (79)
Phoenix	
El Centro	
Lukeville	GJBX-12 (80)
Salton Sec.	
Ajo	
Marble Canyon	GJBX-16 (80)
Grand Canyon	GJBX-35 (80)
St. Johns	GJBX-126 (79)
Gallup	
Shiprock	GJBX-116 (79)
Mesa	
Tucson	
Clifton	GJBX-23 (79)
Silver City	
Nogales	
Douglas	
Kingman	
Prescott	
Williams	GJBX-59 (79)
Las Vegas	

(2) Hydrogeochemical and Stream Sediment Analyses (HSSR)

Salton Sea	NTMS	GJBX-113 (80)
Prescott	NTMS	GJBX-122 (79)
Williams	NTMS	GJBX-71 (79)
Las Vegas	NTMS	GJBX-123 (78)
Kingman	NTMS	GJBX-122 (78)

(3) Papago Indian Reservation, Water Sample Analysis

GJBX-102 (79)

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